State & Private Forestry
FOREST HEALTH PROTECTION
Northern California Shared Service Area

Date: December 1, 2022

Topic: Insect and disease conditions on the South Fork Sacramento Project, Shasta-Trinity National Forest (FHP Report NC23-001).

Key Points and observations:

The South Fork Sacramento Project, located in the Wagon Creek - Sacramento River watershed, is approximately 21,400 acres of overstocked stands, meadows undergoing conifer encroachment, and high use recreation areas all within three miles of the city of Mount Shasta. The project emphasizes reduction of stand density to improve forest health and fire resilience, aggressive meadow restoration, and improving recreational opportunities for the west side of the District.

Prior to European settlement, the area forests were generally more open and dominated by fire resistant ponderosa pine, incense cedar, Douglas-fir, and oak species. Changes in wildfire suppression and forestry practices has resulted in a species composition shift from ponderosa pine and Douglas-fir to more shade tolerant species, such as white fir, and tree densities much higher than they were historically or are sustainable. Prior to settlement, wildfires were frequent, every 5 to 15 years. These wildfires would naturally manage understory densities, including trees intolerant to fire such as white fir. It has been over 100 years since a large fire has burned in the project area and the area has had limited timber management in the past 30 years.

Current densities in the project area have reached levels that exceed site capability leading to tree stress. Drought and increased temperature are further stressing the trees, leading to vulnerability to insects and disease and tree mortality. Tree competition and mortality is observable in stands across the landscape. On our many visits to the project area we have observed western pine beetle causing mortality in ponderosa pine, dwarf mistletoe causing heavy brooming and mortality in Douglas-fir which can increase the risk of wildfire, and fir engraver beetle causing injury and tree mortality in white fir. Heterobasidion and Port-Orford-cedar root diseases are present in the project area but are discussed in separated documents. If no management occurs these insects and diseases will continue to cause tree mortality and under current and projected climate models, hot droughts are expected to continue to stress the stands leading to greater amounts of tree mortality.

Deteriorating forest conditions at the recreation sites are fueled by high tree densities, drought, and human-caused damage to stems and roots which have led to insect and diseases causing increased tree mortality.

Conclusions:

In California, droughts are a regular occurrence, but the 2012–15 drought, which was characterized by large precipitation deficits and abnormally high temperatures and in some areas was the most severe in 1200 years (Griffin & Anchukaitis, 2014) taught us many lessons. This drought resulted in progressive canopy water stress and substantial mortality of dominant and co-dominant trees, much of which was attributed to western pine beetle (*Dendroctonus brevicomis*) (Fettig et al. 2019). Higher stand densities can lead to greater water competition and drought stress (Fettig et al. 2019), and higher density of conspecific trees can lead to greater bark beetle infestation (Smith et al. 2005). Drought has continued after a single good water year and the current drought (3 years so far) is also characterized by large precipitation deficits and high temperatures.

Substantial basic and applied research has been devoted to the development of tools and tactics for mitigating undesirable levels of tree mortality attributed to bark beetles (Fettig & Hilszczanski, 2015). However, Fettig et al. (2021) suggests that substantially lower stand densities are required to maintain adequate levels of resistance in contemporary yellow pine forests than previously considered by most natural resource managers. Of note, it appears stand density levels <100 SDI are required to promote high levels of resistance, and those <150 SDI are required to promote moderate levels of resistance to severe *Dendroctonus* spp. population pressures. Maintaining

western yellow pine stands at these densities would represent a substantial change from current management prescriptions (e.g., maintenance of 200–240 SDI).

During the 2012-2016 drought, density reduction treatments that relied on mechanical thinning alone had neutral to positive effects on conifer survival (Steel et al. 2021). The direct effect of prescribed burning (fire injury) was positively associated with beetle infestation. However, increased infestation rates following prescribed burning are typically short lived (i.e., within the first 5 years) and result in limited tree mortality (Stephens et al. 2012, Fettig and McKelvey 2014). Both pre-drought tree growth and observed beetle infestation during the drought were strong predictors of tree mortality. For all species (including yellow pines and white fir), slowly growing trees were more likely to die during the drought while rapidly growing trees frequently survived (Steel et al. 2021).

Dwarf mistletoes are parasitic plants that rely almost entirely on their hosts for their water and nutrient needs. The transpiration rate of dwarf mistletoes can be many times higher than the rate of their hosts, potentially causing or exacerbating host water and nutrient deficits, especially under drought conditions (Hawksworth & Wiens 1996). Douglas-fir in the South Fork Sacramento River Project area is severely infested with Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*), with stands ranging in Dwarf Mistletoe Rating (DMR) from 3-6 (Hawksworth 1977). Intensification of dwarf mistletoe is related to the abundance of dwarf mistletoe in the stand (Geils and Mathiason 1990), removing infected trees will reduce disease severity and future impacts of dwarf mistletoe in a stand (Hessburg et al 2008). Dwarf mistletoe seeds are explosively ejected from fruit and can travel over 50 feet, but typically travel 30 feet or less. Most infections occur within 15 feet of a seed source (Hawksworth and Wiens 1996). Disease suppression and prevention are the most effective control strategies in dwarf mistletoe management. Suppression is achieved by reducing disease incidence and severity and should be focused on removing infected trees. Prevention is achieved by spacing residual host trees far enough apart to prevent seed dispersal. Non-host tree species can be retained between hosts to provide a physical barrier to seed dispersal. In recreation sites, where heavy dwarf mistletoe brooms may fall and cause injury and property damage, dwarf mistletoe infections can be pruned out.

Recommendations:

- Thinning in the plantations and natural forests to reduce BA to 80-100 will reduce density and increase resilience to bark beetle attack. Sugar pine and other non-host species should be retained where found to increase species diversity further improving resilience of stands to tree mortality.
- Removal of Douglas-fir with a DMR of ≥ 2 will reduce disease impacts including tree mortality.
- Residual Douglas-fir crowns should be spaced ≥ 30 feet to prevent future disease intensification.
- Stands should be monitored at regular intervals (<5 years), scored using Hawksworth's DMR System, and additional trees removed if necessary.
- Pruning hazardous brooms out of a small number of high value Douglas-fir with a DMR of >2 in recreation sites, as an alternative to removing them, can be considered. Care must be taken to remove all Douglas-fir within ≥ 30 feet of the crown of these trees and Douglas-fir regeneration should be removed from within this zone on a regular interval (1-3 years).

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